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e Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

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[OFFICIAL NOTICE.]

New England Association of Gas Engineers.

SECRETARY'S OFFICE, LYNN, MASS., Jan. 11, 1893.

The Twenty-third Annual Meeting of the New England Association Gas Engineers will be held at Young's Hotel, Boston, on Wednesday d Thursday, February 15th and 16th. The first session will be called order at 10 o'clock on Wednesday morning. A cordial invitation to present is extended to the friends of the Association.

C. F. PRICHARD, Secretary.

BRIEFLY TOLD.

"EXPERT" OPINION ON THE DEPTH AT WHICH GAS PIPES SHOULD LAID.—During the mild weather that prevailed in the winter seasons the four years prior to the present one, gas suppliers had much to ngratulate themselves over. In the first place, deep, penetrating frost s the unlikable effect of displacing and disjointing gas mains, and this result is conducive of more real damage and loss than that which arises from a second effect (really, perhaps our second effect should have been given the first or place of honor in the category) of frost persistence, the reception from and the remedying of complaints of consumers that their "light is out." While, however, the complaint of the consumer that his light either only glimmers or is "out," admitting even that these complaints come to hand in this respect with immensely greater frequency than do the discoveries of broken mains, it is still a permanent knowledge that the former can be restored with comparative ease as measured with the labor and cost involved in repairing the latter. In fact, to use the words of a superintendent whom we recently heard speaking about these very twin complications, the stopped service pipe of the consumer bears, in its effect upon the internal economy of operation of a gas company, the same relation to rupture in the body or the joints of a street main as the hum of a mosquito does to the kick of a mule, in respect of the effects occasioned by either of the latter on the mind or the frame of the body human. In any event, January, 1893, will long be remembered by gas makers as the month of the year in which they were doubly martyred, for on both sides were they assailed. The complaint clerks had no time for eating, and the outside men could neither eat nor sleep; day and night were alike to them. Nor were the purveyors of electric currents much better off; and strange to relate, those who supplied currents from central stations through underground conduits were greater sufferers than their brethren whose dependence is placed on the erratic overhead conductor. Of course, all this so far has but little relevancy to the title of the comment, but it will serve as an introduction, that has been all too familiar to the gas maker in the recent days, to a line or so upon a wonderful variance in "expert" opinion recently advanced at different points in the State of Pennsylvania on the matter of determining the safe or correct depth at which gas mains should be placed. In common with the rest of us, the Gas Companies and gas consumers of Pittsburgh, Pa., experienced the visit of the frost king and suffered from his touch. The odor of escaping gas could be encountered at many varying points, and so frequent was the report of the same that the newspapers took the matter up, wherefore they had to have recourse to "expert" authority for an opinion as to the why and because. One Mr. L. A. R. Winans, who is reported as being a member of the firm of "Winans & Co., gas experts and private meter inspectors," on being appealed to, gravely said that the fractured mains in the city that were responsible for the escaping gas had been put too deeply in the ground; that the right or true depth at which they should be buried should not exceed 2 feet! He further averred that when he was in Chicago, at the time the mains of the then opposition Companies were being constructed, the practice followed was to "plant" the pipes at an average depth of 20 inches. Admitting that to have been the case—and we have no reason to doubt it, for some of those Companies were built on rather peculiar lines of "economical" engineering—we are also confronted with the fact that one of the principal sufferers the country over during the cold spell, from ruptured mains, was the Chicago Gas Trust. Mr. Winans fortifies his expertness by remarking that mains should be pretty near the surface, because they "can be the more readily got at it in case of rupture or other diseased condition;" and he could have also added, it seems to us, without fear of successful contra-

diction, that the nearer they were to the surface, the oftener they would be ruptured or become "diseased." He also submits that the mains ought to be placed in "cast iron cases, and at a depth not in excess of one foot from the surface, with 'smell-offs' every few hundred yards along the route." And there you have it! Expense amounts to nothing with Mr. Winans; neither does common sense! Taking leave of Mr. Winans and his beliefs, we come to Chief Engineer Park, of the Philadelphia Municipal gas works, who has also been beset with trouble in the distribution department. Perhaps one of the worst specific instances which he had to deal was one that occurred on Delaware avenue, in a section of pipe that conveyed gas to the wharves of the Pennsylvania Railroad. Chief Park, however, explains the defective condition of things there by remarking that when the main was originally laid, because of some matter related to expediency, it was buried at a depth of but 14 inches from the surface; now, however, as a remedy for all time, he declares, when the ground is restored to its normal condition, that pipe shall be relaid at a depth of not less than 36 inches. And thus do we find how "experts" differ in their opinions and beliefs. Meanwhile it is safe to say that the present winter has more than ever convinced gas engineers that the only safe policy, which in the long run means economical policy, is to put their pipes at a depth to be mainly determined by the consideration of the frost line in earth that is likely to be reached in their respective localities. It may cost somewhat more at the start, but that cost will in time be repaid with more than fair interest.

Mr. Hoar's Proposition to Reduce Gas Rates in Boston.—In our item columns will be found the draft of a bill presented by Mr. Hoar to the lower branch of the Massachusetts Legislature, which virtually directs that gas shall not be sold in Boston at a rate in excess of $1 per 1,000, and that the illuminating power of the gas shall not average less than 25 candles. Mr. Hoar specifies in the act that these stipulations shall apply generally to cities in Massachusetts having a population of 200,000 or over, but he might just as well have said Boston, since that is the only center in the State holding 200,000 "inhabitants, or over." The measure is a vicious one in principle, and can be traced directly to the fatuity of the actions of the present controllers of the gas supply of that city when they, on the expiration of certain contracts that existed between certain large consumers and the old Boston Gas Light Company, refused to renew the same on the former terms. Seemingly secure in a monopoly, the prentice hand of the new comers was immediately raised in insolence, and they would have their pound of flesh. The result is the Hoar measure and a condition of affairs that betokens feverish unrest on the part of the consumers at large. Leaving the Bay State folks out of the question, for they merit no commendation for the grudgingly given concessions of a few weeks ago, the Hoar scheme is vicious because it is in the nature of special legislation and seriously threatens to injure the power of the State Board of Gas and Electric Light Commissioners for good. This Board recently recommended the settlement of the question of gas rates in Boston on a basis that satisfied the protestants, at whose instance the matter was brought before the Commissioners, and it is impossible to honestly assert that sufficient time has been allowed wherein to demonstrate that these conditions are equal to the fair protection of the interests of both consumer and Company. When time (not necessarily of long duration either) has shown that the Company has been unduly advantaged, then let the protestants come to the Commissioners again for relief; otherwise, if the Legislature interferes with direct hand, by taking to itself the power that it has delegated to the Commissioners, then will the gas consumers of the whole State have good cause to declare that the Commissioners cannot be trusted by them to do that which is in accordance with judgment founded on the merits of the cases they examine. We sincerely hope that Mr. Hoar and his colleagues will remit the Boston situation (even if they do so by direct mandate) to the State Board for consideration.

Notes.—W. H. H. Daniel, Chairman of the Committee on Gas and Street Light of the Columbus (Ga.) City Council, is asking for estimates for the installing of an arc lighting plant up to the maintenance of 150 lamps, to be operated on municipal account. This likely is the result of the crusade made by Mr. E. H. Jenkins, of the Columbus Gas Company, against the local electric light company, in his attempt to secure this year a portion of the public lighting, the same to be done by gas. His figures were low enough to cause the City Fathers to believe they were paying the local electric company too high a rate.——At the annual meeting of the Ravenna (Ohio) Gas and Electric Light Company the following officers were elected: President, Charles Merts; Treasurer, W. H. Beebe; Secretary and Superintendent, Eugene Hyde. The last named is a son of Mr. G. A. Hyde, of Cleveland, Ohio.

[Prepared for the Journal.]

Mr. Addicks' Presentation of the Gas Association Problem.

By Col. Clement A. White.

Quite sufficient time has elapsed since Mr. W. R. Addicks, of Boston, Mass., read, before the American Gas Light Association, his paper,* entitled "A Gas Association and Its Members," to permit all the flourish and fancy of an apparently new thing to have vanished from our minds, good solid thought to have settled in place, and reason to have resumed its accustomed sway. We have had ample time to look at that paper from every side, to disect it—to learn what, if any, part of it could prove a conflicting element as between the present various Associations and the proposed National one, upon what point or points there could arise jars or bickerings, either in the membership or management, and to consider whether the adoption of its suggestions would be wise, and, if adopted and carried into effect, what would be the result to our profession as a whole, as well as to consider the resultant action as applying to the gas companies of the country.

The topic is not a new one, Mr. C. J. Russell Humphreys, of Lawrence, Mass., having read a paper of somewhat similar import before a meeting of the Society of Gas Lighting, in New York City, which was published in the American Gas Light Journal, of September 17th, 1889.

With the suggestion of the appointment of a committee on "Papers and Research," as a standing committee of each of the Associations, and the formulating of a plan of action on subdivisions of the same subject, Mr. Humphreys drops the matter so far as concerns any plan for carrying the idea to a successful issue.

While it was announced at the Boston meeting that Mr. Addicks had no knowledge of the paper of Mr. Humphreys, to which I have referred, he seems to have taken hold of the matter at the very point where the latter gentleman permitted it to go out of his mind, or, rather, where he ceased action thereon; therefore, while the paper cannot be considered as a new one, it certainly can and must be accepted as a novel plan of carrying out an old idea.

Before taking up the general plan of the official formation of the National Association and the few changes needed in the constitution of the Associations now in existence, so that they may conform to the former, let us for a moment look at the effect, pro and con, bearing upon the existing Associations. The question has already been asked, "What will be the effect of the increase in the number of Associations of this character?" So far as now predicated, there is no increase called for—the present American assuming the style of the National; but even were this not the fact, so far as concerns the district Associations, there is full and ample room for many more. There are many engineers and superintendents, especially of the smaller companies, whose income will not permit them to take long and expensive journeys, so that they may be present at the meetings of any one of the existing Associations. The Companies with which they are connected and to the service of which they are most entirely devoted, either from a wrong idea that money so expended is simply wasted, or from the fact that they will not see in what manner they are to receive any benefit from such an expenditure, utterly refuse to pay the absolutely necessary expenses of their engineers or superintendents on such occasions, so that they must, perforce, remain at their homes.

Upon making application for the power to make such an expenditure, they are told that they can read all that may be said or done in the American Gas Light Journal, with which we generously supply you, and thus get the pith of the whole matter! So it is that the officials of such companies cannot become members of the American Association; and, unless they are residents of Ohio, and can become members of that Association, I see no place for them. For such, State Associations would prove a refuge indeed.

It is not necessary to enter further into the question of the advantages to be derived to the members of our profession by increasing the number of Associations, that not being a matter under discussion.

The present arrangement of the American and various Associations is such that there can be no conflict of authority, no clashing as to rights. Each is to itself supreme. The members of the American Association are nearly all members of one or the other of the various Associations now in existence, and this fact tends to create a spirit of harmony. If any Association is to prove or does prove the sufferer, it must naturally be the American Association, from the fact that, as its membership is as above stated, those members owe an allegiance to their district Association, which appeals to them most directly for its main-

* See Journal, Nov. 14, 1892, p. 694.

tenance and success. This may tend to cause a lack of papers to be read at the meetings, a carelessness in attention during the sessions and a comparative lack of vim in the discussions. This should not be so; for while to many it would be a tax to prepare a paper for their own Associations, as well as one for the American, yet there is among the membership of the latter quite a number who are continually engaged in experiment along the beaten path as well as research into the new, who are as well fluent writers, that there should be no lack of material presented, and that in such form as to make a lively and profitable discussion an assured fact. The great question is how to touch and awaken the right spirit, to cause it so to take hold of each and every member of the American Association, that he will feel that upon his exertion, his individual effort, the success or failure of its meetings depends; and I can but believe that the only way to reach this most desirable point is in a closer connection between the various Associations and the American Association, and a harmonizing of the interests common to both; and while each Association shall be thoroughly independent as to its date of meeting, the conduct of the same and the subject matter presented and the manner and style of their discussion, yet there shall be a close connection amongst the district Associations, one with another, and with the National Association, by means of the Committee on Research, as proposed by Mr. Addicks, and to whom all important questions may be referred for investigation and report.

It is needless to consider the "objects of a Gas Association," as set forth in the preliminary part of the paper. The fundamental principles upon which have been erected the various Associations, from the inception of "The New England," the parent Association, down to this date, have been substantially those proposed by Mr. Addicks, saving the one item of "the adoption of standards of similar designs." Although such system of "standards" has not been embodied in any of the constitutions, yet the basis on which they were formed has been broad enough to admit of that far-reaching subject amongst their discussions. To be fair in the matter, a vast amount of time and money has been expended by the manufacturers of gas meters in the preparation of standard meter unions, while the Society of Gas Lighting has, prepared the plans, and, by securing the co-operation of the manufacturers of cast iron pipe, paved the way for the introduction of a standard of sizes in cast iron pipes and specials for the same.

It is doubtless true, as stated in the paper, that the standard is not complete—that no provision has been made for the use of cement joints. How small an obstacle, and how easily removed.

I now come to the consideration of the plans of organization as proposed, and will consider them as presented in the paper.

First. A National Association, with active members composed of all engineers and managers of gas companies.

The Association that would naturally form the National would be the present "American." One question co-incidentally arises—the membership, as proposed above; but one class of membership is provided for in the National, in fact in all of the Associations—to wit, an active membership. With the exception of the Ohio Association, in which no provision is made for associate membership, as a special class, the members are of three grades or classes—active, associate, and honorary. I do not believe that Mr. Addicks proposed to do away with these several classes; rather that in the multitude of other matters he simply overlooked them. Should, however, that have been his intention and purpose, I cannot believe that any one of the Associations would agree to take such a plan into consideration, not to speak of adopting it.

By the elimination of the manufacturers, who form the bulk of the "associate membership," from the Associations, the most important work, or, rather, the one upon which Mr. Addicks places the greatest stress—the standards—would certainly fall to the ground. Of what interest would such a system then be to those gentlemen? Wherein would they be benefited? From what source would spring the needed interest that would lead them to cast aside a large stock of expensive patterns and make new ones? They have been thrown out from our Associations, have no vote or fellowship therein, with the result that each and every one of them would turn their faces against any such proposal, and backward we go to the old "take it or leave it" style, which is certainly far from the desire of anyone in the profession.

Second. "Each Association should have its own committee room and library located centrally." With the exception of the National Association, this is a matter that should be left entirely to the judgment and consideration of the district Associations. Local conditions would enter so much into a general consideration of this question as to make it entirely impracticable to force such a step as a part of the internal economy of each Association.

There is no question that, if a central location, one handy to a large majority of the members—a place where any member could go in quest of information and advice—could be established, it would be of undoubted advantage. To accomplish such an object would entail the expenditure of quite a sum of money in the way of the fitting up of the rooms, the procuring of and caring for a library, and, over and above all, the expense of a person who will be competent to give aid and comfort, in the way of needed information and advice, to its members. I very much doubt if any of the district Associations would care to indulge in such a luxury, or permit it to be foisted upon them, as a requisite of their being taken into the fold of the National Association. Each Association should be the judge of its wants in that direction, and its ability to provide therefor.

I firmly believe that the time has arrived when the American Association, even if the scheme under consideration fails, should have an established, centrally-located office, fitted up, for the present, with a library, and necessary office appurtenances. The nucleus of the library could undoubtedly be obtained by gifts of the various members, and its extension provided for as deemed best by the Association at its meetings. To this office every member of the American Association should have free admission. Here he may receive his mail while visiting the city, may be supplied with material and desk room for correspondence, and where he may at all times, either in person or by letter, apply for information and advice upon any question pertaining to our profession, with the assurance that his query will receive prompt attention, and, if the information desired cannot be furnished direct, that he will be placed in communication with the person or persons most likely to meet his want. This is simply a beginning—and then should be taken into consideration the fact that later on there would naturally be established a testing room, properly equipped to meet any demand upon it.

There is no question of compulsory membership, either in the district or National Associations, hence there can be no discussion upon that point.

Third.—In the matter of "the officers and committees of each Association being identical in make up as to duties and powers," there does not seem to be much choice. With the exception of a change of title of the presiding officer of the district Association from President to that of Chairman, from Vice President to that of Vice-Chairman—and I fail to see the advantage or desirability of such a change, the elimination of two of the Vice Presidents as now provided for under the American Association—at its best, on account of the vastness of the field from which the membership is derived, a change most undesirable, the appointment of the Committee on Standards and Committee on Scientific and Practical Investigation, with additional duties placed upon the Recording Secretary, called in the district Associations Corresponding Secretary, the officers are practically the same as at present. Parliamentary law undoubtedly fixes the duties of all officers as well as committees, as also the mode of procedure in all matters coming under their respective jurisdiction. The proposed change is, therefore, simply a distinction without any difference.

The officer provided for in the district Association not heretofore spoken of is the stenographer. As each Association, at its meetings, employs a stenographer to take down the discussions, etc., and prepare copy of the same, and when his duty ceases his pay ends, I cannot see where any of the Associations could derive the least benefit from such a person as an established official stenographer. What would be his duties? Again, to be an officer, it is but natural that he should be a member, and to become that he must be of the profession; and, fulfilling this, why not make him Secretary, and thus do away with an extra official? The present seems to me the simplest, the wisest plan, and as in the formation of the district and national Associations no extra duty will be laid upon the various Secretaries of the former, other than having an extra copy of the proceedings prepared by the stenographer and forwarded to the Secretary of the latter Association, neither can there be any need for extra officers not heretofore spoken of; they would be worse than useless.

I now come to the consideration of the proposed classification of members. I confidently believe that Mr. Addicks is not only thoroughly honest in the plan that he has presented, but anxious that it shall become an established fact, an unquestioned success; yet at the very outset he proposes to do or have done the one of all things that will prove a great stumbling block, in fact, I may say, which will prevent the fulfillment of his wishes. He proposes that the membership, not only of the National, but of the various district Associations, shall "be graded according to standing and experience of candidate." Could this be made to apply, as the phraseology of the paper seems to convey that it does, only to members elected after a certain date, and not to the present member-

ship, and if so, where would the advantage or desirability of such grad ation come in? Again, who shall be the judge—the one who shall discriminate; who shall select the sheep from the goats? Or, shall it be done as specified in a constitutional amendment? There is hardly a member of any one of the Associations who would agree to such a discrimination. The platform upon which the Association rests is too broad, too charitable, its purposes too grand to permit of such a broad and sweeping separation of its members, and which, if permitted, could not fail to speedily wreck each and every one of them. Where, under such a gradation, could such salient features as "the interchange of professional views," "the cultivation of good-fellowship in the profes sion," find a ground to stand upon? As one of inferior grade would not care to voice his ignorance to one of the highest, neither would he of the latter so lower his dignity as to even listen to such cry, were it uttered. Where true, honest good-fellowship is to make itself felt is on some level where it is not beneath the dignity of the greatest to mingle with others of their fellows who may not be blessed with ripe experience or great learning, but who are starting on the journey all must take to reach those points. Once place such an impassable barrier as the proposed one in the way, and it would be simply a question of a very short time until our Associations would exist in history alone.

In considering the change as applied to the National Association, the duties of the Secretary should be taken into consideration. I have already expressed an opinion that it did not seem to me desirable to so change or add to the duties of the Secretaries of the district Associations as to require that they should devote their entire time to such duties. With the proposed National Association it would be different. The duties of that office would be very largely increased; in fact they are now so onerous that, did we count fairly and honestly the nights as well as days of labor performed by the Secretary of the American Association, we would find that at least eight out of the twelve months of the year are required by and devoted to the performance of his duties. With the additional work of the preparation and distribution, quarterly or even yearly, of a journal of proceedings, the care of the proposed office, the necessary correspondence that will need his attention, he will have ample to do, and must be a good and systematic workman to accomplish in proper season the full measure of his task. It is my idea to have but the one Secretary, call him by what style or title you will, and he shall devote his entire time to the duties of his office. Such a position calls for an exceptional man. He must not only be well posted in the technical as well as the practical part of our profession, but also a thorough executive officer, one who can claim the confidence of the members and be able to represent them or the Association upon any or all occasions.

The remainder of the scheme is merely a matter of detail, and as its various suggestions, such as the appointment of the Committees and the character of their membership, would naturally bring out quite a discussion at the next meeting of the American Association, when the entire matter, now in the hands of the Council, will be reported back, I hesitate from advancing my views until I am in possession of the report of the Council.

There can certainly be no question but what, if the proposed scheme can be carried out on some good, sound basis, agreeable to all of the Associations, the profession will be the gainer. Questions of great moment that have been considered over and over again, with but little gain to any in theoretical or practical knowledge, can then be taken up in a thoroughly systematic manner, and when the results of the several investigations are sent to the Committee of the National Association, to be by them formulated for presentation at its meeting, as well as reaching all its members through the "Journal of Proceedings," it will be found that, if the desired ultimatum has not been reached, a vast step forward has been made and we are by so much the better prepared to go on with future research and development.

Such result will not only serve to whet the appetite of the conscientious worker, but will spur every member to a higher tone of interest, and consequently an increase in knowledge of our profession, and just as surely prove of great and lasting benefit to the Company which he represents. There is no such point reachable in any profession where a man can have accuumulated such a store of knowledge that he may sit down and fold his hands. It is either forward or backward. The former means constant watchfulness, study, experiment, hard work, rewarded by success. The latter ease and comfort, with a rapid deterioration and final relegation to a place among the "have beens."

THE Seattle (Wash.) Gas and Electric Company will add 13 miles of mains to its distributing system this season. None of the pipe will be of a smaller diameter than four inches.

[Prepared for the JOURNAL.]

The Harris Process for Generating Gas.

By MR. FREDERIC EGNER.

Under above title there was published, December 7th, 1891, in the JOURNAL, a copy of drawings and specifications accompanying U. S. Patent No. 463,965, and I propose now to give an account of the results of an investigation into the practical operation of the system, made during the month of January, 1893. As the apparatus and proposed method of operation were described in the article mentioned, to avoid repetition, the reader is referred to it, as substantially correct, and there remains but little to add to make the whole intelligible to the professional gas man. The "process" is now in periodical use at Connersville, Ind., Maysville, Ky., and Washington, D. C. The Connersville apparatus is of the most recent improved pattern, while at Maysville the original machine is employed to make fuel gas two or three times each week. The apparatus at the latter point consists of a Harris converter or gas generator, a dry scrubber, two multitubular condensers, a steam boiler, No. 3 Roots blower, Worthington meter for oil, pumps and a 100,000 cubic foot telescopic holder, giving, when cupped, 50 tenths pressure. During a run of 33 minutes, on January 5th, 17,360 cubic feet of apparently 10 candle power gas was made, and 44 gallons of crude petroleum (so it seemed to be) used. It was claimed that 8 pounds of coal (bituminous) per 1,000 cubic feet was all that was used; but there was no way to verify this during my short stay. The blower made 80 revolutions per minute against a pressure of from 28 to 30 inches, and how much air it would force through the "converter" under those circumstances the writer cannot say, not knowing the condition of said blower. But everything that went into the converter and did not stay there had to go into the holder, as there was no other outlet. The gas was seen burning in several private residences, distant one fourth to one-half mile from the works. Much of the principal gas main was exposed to the atmosphere, and although the outside temperature at the time was at or near the zero point, the gas burned well, and gave, apparently, entire satisfaction. Four samples of this gas were obtained by an able analytical chemist, on behalf of a gas manager of acknowledged ability, who is *not* interested in the "Harris process," and who kindly gave the writer a copy of the recorded analyses, one of which is included in this article. The recorded analysis of his gas, given me by Mr. Harris himself, does not differ much from the last, as will be seen later on. The promoters of the "Harris process" claim to get better results in heating with their gas than are obtained by using equal volumes of natural gas, although the fact that the theoretical heating power of the latter is fully double that of the former gas is not questioned. This claim is not so very unreasonable, when it is known that in a report prepared by Professor Phillips for the Geological Survey of the State of Pennsylvania it is stated that the available heat units of a cubic foot of natural gas ranged from 261.19 (the lowest) to 324.21 (the highest) in the samples taken from a number of stations within the natural gas districts.

By this we are to understand that with present known appliances, all the combustibles contained in a cubic foot of natural gas cannot be utilized. This was neatly illustrated by a gentleman interested in the process in the following manner: He folded tightly a large newspaper and threw it on a glowing grate, where it lay burning slowly. He then threw a similar paper, but not folded, beside the other, and this was, of course, quickly consumed. "Now," said he, "that is the way I explain this thing. In the first place, the air cannot get at the paper so well to aid in its combustion; but it was different with the other. So with natural and our artificial fuel gas. Though the first is nearly all combustible, in practice much passes away unconsumed, whereas the incombustible and otherwise undesirable nitrogen in the artificial gas really aids combustion in this sense, that, by spreading out, as it were, the combustibles, the oxygen of the atmosphere can get at and thoroughly convert them; and, furthermore, by its volume, which has, of course, also been intensely heated by the burning of the combustible gases, aid in carrying the heat to the point desired." This is at least a very neat way of stating the matter. The writer saw the gas burning under a large Babcock & Wilcox boiler, at Connersville. This boiler was arranged so that solid or gaseous fuel could be used, or both.

The gas furnace was more efficient than the coal furnace, but there were no means at hand by which the amount of gas used could be ascertained beyond reasonable doubt, and hence that test did not count for much. The apparatus at Washington and Connersville differs from that at Maysville in appearance, and is said to be better. It certainly makes a better appearance. It is a cylindrical boiler iron shell, 21 feet 6 inches in diameter, and 13 feet 6 inches high, covered by a dome, in-

creasing the height some 6 or 7 feet. Within this shell is the furnace, which is from 4 feet to 5 feet in diameter, and the full height of the apparatus. The serpentine passage mentioned in the patent, fitted with fire clay balls, surrounds the furnace in a spiral form. The air, oil and steam pipes are all contained within the fire brick lining of the shell, and this material is all preheated before entering the furnace proper. The aim in operating this apparatus is to force into it just enough air to convert, by means of its oxygen, all the solid or liquid carbon fed into it into combustible gas and the unavoidable nitrogen. Properly handled, neither free oxygen nor carbonic acid is to appear in the gas, but the results are to be as stated, carbonized combustible gases and nitrogen. The following table will illustrate how near this object has been arrived at:

No 1 represents Harris fuel gas, according to the independent analysis referred to before.

No. 2 represents analysis of Harris gas, given me by Mr. Harris.

No. 3 represents an average sample of natural gas.

No. 4 represents a 22-candle power water gas.

No. 5 represents a 17-candle power coal gas.

The heat units which the gas could develop per cubic foot were calculated by the writer.

	Per Ct. H.	Per Ct. O.	Per Ct. CO_2.	Per Ct. CO.	Per Ct. CH_4.	Per Ct. C_2H_4.	Per Ct. C_6H_6.	Per Ct. N.	Heat Units.
No. 1...	14.92	.35	4 85	22.29	.28	3.42	5.18	48 71	432.64
" 2...	14.70	.30	3.60	10.70	16.00	13.70	.00	41.00	487.34
" 3...	22.00	.80	.60	.60	67.00	6.00	.00	3 00	884 63
" 4...	37.20	.06	.14	28 26	18.88	11.29	1.53	2.64	688.23
" 5...	45.58	.....	3.67	6.64	34.90	6.46	.29	2.46	669.79

According to analysis No. 1, 1,000 cubic feet of Harris gas is composed of—

Carbonic acid	48.5	cubic feet.
Marsh gas	2.8	"
Olefiant gas and hydrocarbon vapors	86.0	"
Carbonic oxide	222.9	"
Oxygen	3.5	"
Hydrogen	149.2	"
Nitrogen	487.1	"

—and, at 32° F., would weigh 68.53 lbs., divided up into 1.82 lbs. hydrogen, 14.57 lbs. oxygen, 38.74 lbs. nitrogen, and 13.14 lbs. carbon, if the gases could be resolved into their component parts.

According to the statements of the operators of the Harris plants at the points named, 8 lbs. of coal and 13½ lbs. of heavy petroleum were placed in the apparatus for each thousand cubic feet of gas made, or a total of 21½ lbs. of carbonaceous material. As but 13.14 lbs. of carbon appears in the finished gas, as shown, the statements we sometimes hear about patent processes, that more is claimed to have been obtained than was put into the apparatus, is pretty effectually disposed of, in this case at least. The whole matter deserves more than a superficial or prejudiced consideration; and if the reader will carefully consider the subject treated in this paper, he will find that fuel gas is not "fool gas," as some have facetiously styled it. It is well understood that the practical efficiency of coal as fuel applied direct is far below its theoretical value, as developed in the laboratory, and it is yet an open question, if not the loss necessarily accompanying the conversion of solid into gaseous fuel is more than made up by the subsequent higher efficiency of what is left, because of greater ease to apply and use the same with more economy. It is, therefore, to be regretted that the managers of the Harris fuel gas plants have not much use of a few simple appliances, as they could easily have done, so that the relative value of coal and fuel gas could have been accurately established in a practical manner, instead of resting still at this time, on theory, unsupported, though honest assertion, and a few not well conducted or authenticated experiments. What a boon it will be to the inhabitants of the many smoky cities, here and abroad, when gas for fuel shall be produced, which people of all means may afford to use.

[Continued from page 113.]

Generation of Light from Coal Gas.

[The third of a series of four Cantor Lectures, delivered by Vivian B. Lewes, F.I.C., F.C.S., before the English Society of Arts.]

I have now brought before you the work on which our present ideas as to the source of the luminosity in hydrocarbon flames is based, and I cannot but think that the evidence collected by Davy, Stein, and Heumann, Soret, Burch, and Stokes, has fully established the truth of the solid particle theory first enunciated by Davy.

But in admitting this, we must not overlook the debt which we owe to Dr. Frankland, as although the mass of evidence seems conclusively to point to carbon particles, and not incandescent hydrocarbon vapors, as being the cause of luminosity in coal gas, oil lamp, and candle flames, yet had it not been for his putting forward his theory, and supporting it in the way he did, we should probably never have had the masterly work by which Heumann conclusively established the truth of Davy's hypothesis, or the smaller contributions which have so strengthened its position.

Three years ago I had the honor of delivering before you a course of Cantor Lectures on "Gaseous Illuminants," and whilst searching flame lore in order to find the exact position of our theories as to luminosity, it seemed to me that in the present position of our knowledge, what was really required was to show how and why these all important carbon particles came to be formed in the flame—was it, as Davy supposed, brought about by the heat of the outer portion of the flame decomposing the hydrocarbons in the interior regions, where air was scanty or altogether wanting, into their constituents; or was it, as others supposed, some unfinished combustion which gave the particles to the flame, and so endowed it with luminosity? Could it be that Frankland was right, and that what had been called solid particles of carbon were in reality the densest possible vapors of hydrocarbons. If so, how could they have been produced from the hydrocarbons we know to be present in the coal gas, and was the temperature of a luminous flame sufficient to cause incandescence of such vapor, and yet not sufficient to decompose it? These and a hundred other like thoughts came as a recreation from duller routine work, and experiments made, whenever time could be found by myself and my assistants, have revealed another step in our flame reactions, and have made clearer changes which before had to be explained by assumptions.

In the last lecture of the last series I had the pleasure of delivering here, I dealt with the products of incomplete combustion which escape into the air when we check the combustion of a flame, by practically putting it out before combustion is complete, by withdrawing the heat of the flame for the raising the temperature of other things in our gas stoves and ovens; and whenever a luminous flame is treated in this way, an insidious and disagreeable odor pervades the room, whilst if an atmospheric or Bunsen burner flashes back and burns "at the bottom" the smell becomes almost unbearable. This curious smell has long since been recognized as that of acetylene, one of the simplest of the gaseous hydrocarbons; and the undoubted presence of acetylene in the products escaping from a cooled flame, and the fact that the incomplete combustion of hydrocarbon gases always gives rise to the formation of this compound, suggested the idea that it might play an important part in the changes taking place in the interior of a flame, and experiments were made to ascertain if any appreciable quantity was formed by the destruction of hydrocarbons in the flame gases.

The fact that the unsaturated hydrocarbons only slowly decrease in the inner zone, and then rapidly disappear in the luminous part of the flame, has naturally suggested the idea that it is to these compounds that the flame owes its luminosity; but, as far as I know, no one has attempted to ascertain whether the unsaturated hydrocarbons present at the top of the inner non luminous zone are of the same character as those found in the coal gas.

I had just completed working out these points when, in December of last year, Professor Smithells, of the Yorkshire College, Leeds, read a most interesting paper before the Chemical Society, on "The Structure and Chemistry of Luminous Flames," and as this was published a month before my results, it will be better to take it in its historical sequence. The author devised a very beautiful experiment, by which he was able to show that the bunsen flame consisted of two distinct cones of combustion, which could be separated widely apart, the reason he gives being that—

"When a bunsen flame is burning at the top of a tube in the ordinary way the coal gas is in such excess that the mixture within the tube is scarcely explosive. If now the proportion of coal gas to air be diminished, the mixture within the tube becomes more explosive, and the initial velocity of inflammation of this mixture increases as the proportion of air is increased up to a certain point. Long before enough oxygen is mixed with the gas for its complete combustion, the explosibility of the mixture has reached such a point that the velocity of inflammation is greater than the velocity of efflux from the tube, and so the flame is differentiated into two cones, one of which descends the tube and marks the margin of the explosive mixture. The other cone marks the area of the combustion of the combustible gases which have escaped combus-

tion in the lower cone and are burning at the top of the tube in free air. Now the rate at which the inner cone will descend the tube will depend upon several conditions, one of which is the temperature, another the diameter of the tube, and these conditions suggested a means of arresting the lower cone of flame. By heating the glass tube with a blow pipe flame, at a point about a foot below the top, it was found possible to arrest the inner cone when reascending, the high temperature producing locally a velocity of inflammation greater than that at points above or below, and so fixing the flame. The second method suggested by the foregoing considerations was simply to diminish the diameter of the tube at one point either by means of a metal diaphragm or by slightly drawing out the tube so as to cause a constriction. At the narrow part of the tube the velocity of the ascending gas mixture is obviously greater than elsewhere, and hence a flame which will descend the wider part of the tube will be arrested at this point. * * * With this apparatus, the flame could be divided with the greatest ease, and the two regions of combustion kept separate for any length of time."

Having in this way separated the cones of various hydrocarbons burning with excess of air, he was able to withdraw samples of the interconial gases, and subject them to analysis; and he found that the main chemical change occurring in the inner cone under these conditions consists in the combustion of the hydrocarbons to form carbon monoxide and water with smaller quantities of carbon dioxide and hydrogen; and he also notes that, when the air was insufficient to destroy luminosity, some acetylene comes from the inner cone.

In dealing with the question of the structure of luminous flames, he points out that—

"The glow of the carbon in the yellow region is due to the heat of its own combustion, and is increased, probably, by the concomitant combustion of hydrogen. The view occasionally met with, that the carbon is glowing only by the heat of the burning hydrogen, is manifestly erroneous. The carbon is in the solid state, and must either undergo the usual glowing combustion, or else escape from the flame unburned. As it does not do the latter to any appreciable extent, it must burn, and the cessation of its combustion as a solid mark the limit of the yellow or luminous region of the flame.

"The blue region has been unanimously regarded as a part of the flame where the hydrocarbons are mixed with sufficient air to cause immediate combustion without the separation of carbon.

"The faintly luminous portion which entirely surrounds the flame was not referred to by Davy as distinct from the blue region. Berzelius describes it, and states 'that it is in this outer part that the combustion of the gases is completed and the heat most intense.' Waldie states that it consists of 'the proper combustible mixture,' and is the hottest part of the flame, and to its heat is to be attributed the separation of the carbon within the flame.

"No intelligible distinction appears to have been made between this region and the blue one until 1861, when Kersten attempted to do so; and even his description is not easy to grasp. He appears to have regarded the faintly luminous region as the place in which hydrogen and carbon monoxide coming from the yellow region undergo combustion, ignoring the fact that it surrounds not only the yellow region, but the blue one as well.

"I have only met with one other attempt to explain this part of a luminous flame as distinct from the blue portion, and have not been able to trace it beyond the text books. It ascribes this faintly luminous region to products of combustion—carbon dioxide and water—mixed with air and raised to feeble incandescence; that is, it is not a region of chemical action at all. If for no other reasons, this explanation could scarcely be maintained in the face of the observations made by Siemens, that such products of combustion have no perceptible luminosity at 1,500°.

"The best way to study flame structure seems to me to consist in tracing the development of the flame. By using a very small quantity of combustible—that is to say, in the case of gases, by almost turning off the tap, and, in the case of solids and liquids, by having a very close-cropped wick—we obtain a tiny flame, which is ordinarily called non-luminous. It consists of a hollow, bright blue cone, surrounded by a lilac colored border. If more gas be turned on, or if the wick becomes longer, a luminous spot is developed in the flame. This spot is at first a small fraction of the whole flame, but as the supply of combustible is increased it rapidly extends, the original inner cone becomes a 'vestige,' and forms, in fact, the blue region. Still the original formation is evident, the luminous spot being indented at points corresponding to it.

"The question now arises, is the non-luminous flame a single or a double cone, and in any case, what chemical changes are taking place in it?

"I think an answer to this question may be obtained by carefully watching the change undergone by a luminous flame when air is gradually added to the gas prior to combustion. For this purpose a small flame from a bunsen burner, with the air holes at first closed, may be employed. If attention be fixed on the blue and on the faintly luminous regions of the flame, and the air holes be now slowly opened, the flame loses luminosity, and the two regions grow more distinct, and ultimately become without any perceptible break of continuity in the process, the inner and outer cones of the ordinary bunsen flame.

"If the conclusion be admitted that the blue and the faintly luminous regions of an ordinary flame correspond to the inner and outer cones of a bunsen flame, then we must consider the blue region to mark incomplete combustion—CO, H_2, CO_2, and H_2O being the chief substances there originating—and the faintly luminous part to mark completed combustion—the CO and H_2 above named being burnt to CO_2 and H_2O.

"In other words, I conclude that there is no essential difference in kind between an ordinary luminous flame and a so-called non-luminous flame. The latter may be regarded as a gas air flame with the blue and non-luminous regions at a maximum, whilst the luminous flame is to be regarded as a gas-air flame, with the blue and non-luminous parts at a minimum, and the yellow luminous region at a maximum.

"As it has been repeatedly shown that the dark central part of a luminous flame is a region of no combustion, there only remains now one question for solution—how is the carbon separated in the luminous yellow region?"

And Professor Smithells finally describes the development of a luminous hydrocarbon flame as follows:

"The hydrocarbon issues from the burner or wick—let us suppose—as a cylindrical column. This column is not sharply marked off from the air, but is so penetrated by the latter that we must suppose a gradual transition from the pure hydrocarbon in the center of the column to the pure air on the outside. Let us take a thin transparent slice of the flame, near the lower part of the wick, or close to the burner. At what lateral distance from the center will combustion begin? Clearly, where enough oxygen has penetrated the column to give such partial combustion as takes place in the inside of the bunsen burner. This, then, defines the blue region. Outside this the combustion of the carbon monoxide hydrogen, and any hydrocarbons which pass from the blue region, takes place, and constitutes the faintly luminous region. These two layers form a sheath of active combustion, surrounding and intensely heating the hydrocarbons in the central parts of the column. These heated hydrocarbons rise, and are heated to higher temperatures as they ascend. They are accordingly decomposed, with the separation of carbon in the higher parts of the flame, giving us the yellow region; but there remains a central core, in which neither is there any oxygen for combustion nor sufficiently high temperature for decomposition. This constitutes the dark region of unburnt gases. A flame is, however, not cylindrical, but has a conical, or, in the case of a candle, an inverted peg-top shape. Again, the blue region only surrounds the lower part of the flame, whilst the faintly luminous part surrounds the whole. The above explanation is, therefore, not complete. Let us suppose that the changes have gone on in the small section of the flame exactly as described, and consider how the processes will differ in parts above this section. The central core of unburned gases will pass upwards, and we may treat it as a new cylindrical column, which will undergo changes just as the original one, leaving, however, a smaller core of unburned gases, or, in other words, each succeeding section of the flame will be of smaller diameter. This gives us the conical structure of the flame. Again, the higher we go in the flame, the greater proportionally is the amount of separate carbon, for we have not only the heat of laterally outlying combustion to effect decomposition, but also that of the lower parts of the flame. The lower part of a luminous flame is accordingly cooler and contains less separated carbon than the upper. Now, where the hydrocarbons are cool until mixed with sufficient air for combustion—that is, in the lower parts of the flame—we have every facility for the occurrence of the chemical changes to which the existence of the blue region has been ascribed, and the blue region is here most evident, whereas in the upper parts of the flame, where the quantity of hydrocarbon decomposed—with separation of carbon—by heat is relatively much greater, there is not enough left to form outside the yellow part, the mixture to which the blue region of the flame is due. The blue region, therefore, rapidly thins off as we ascend the flame. But whether the first combustion taking place within the flame is that of the undecomposed hydrocarbon with limited oxygen, we may be sure that the products will contain carbon monoxide, and probably hydrogen, and we shall therefore have all round the flame a faintly luminous region of completed combustion. In this way, then, we may reasonably account

for the existence, position and relative sizes of the four regions of an ordinary luminous flame."

My own work on the subject, which I think supplies the true answer to Professor Smithell's query of "How is the carbon separated in the yellow luminous region?" I will now bring before you.

In attacking this point I felt that the changes and actions must be sought for in the non-luminous zone of the flame itself, and chose as the subject for the experiments an ordinary coal gas flame.

The coal gas used was that supplied by the South Metropolitan Gas Company, and analyses gave as its composition:

Hydrogen	57.08
*Unsaturated hydrocarbons	4.38
Saturated hydrocarbons	33.99
Carbon monoxide	2.63
Carbon dioxide	0.79
Nitrogen	0.96
Oxygen	0.15
Carbon bisulphide	0.02
	100.00

And this gas, when burnt in a standard London argand at the rate of 5 cubic feet per hour, is of an illuminating value which averages 16.3 candle power.

The gas was burnt at the end of an open tube, and the flame gases were aspirated from the center of the flame by means of a small platinum tube 2 mm. in diameter, and were led into a glass bulb-tube, in which the sample for analysis of the total hydrocarbons was collected, and then through two Volhard's absorbing bottles containing 20 cc. of concentrated ammoniacal silver nitrate solution. This absorbs the acetylene with formation and precipitation of silver acetylide and silver, the latter being formed owing to the reducing action of the carbon monoxide, two absorbing vessels being quite sufficient to prevent any traces of the gas escaping absorption. The contents of the two bottles were filtered, the precipitate of silver acetylide carefully washed with water, and then treated on the filter very cautiously with dilute hydrochloric acid, until all action ceases. Acetylene is given off, and the precipitate then consists of a mixture of silver chloride and metallic silver. This, after washing, is digested with dilute ammonia, and the ammoniacal solution, after filtration, is then treated with nitric acid to precipitate the chloride, which is weighed in the usual manner, 1 gram of silver chloride corresponding to 0.09 gram or 87.03 cc. of acetylene (Winkler).

Acetylene Formed During the Incomplete Combustion Taking Place in the Interior of a Luminous Flame.

	Total Unsaturated Hydrocarbons. Per Cent.	Acetylene. Per Cent.
Gas in burner	4.38	0.035
½ inch above rim of burner	4.00	0.340
1½ inches above rim of burner	1.53	0.560
Tip of inner cone	1.98	1.410
Center of luminous zone	0.45	0.045
Tip of luminous zone	nil.	nil.

Showing that in the interior of the luminous flame the hydrocarbons at once begin to undergo decomposition, giving rise to acetylene, which, by the time the top of the inner non-luminous zone is reached, constitute over 70 per cent. of the unsaturated hydrocarbons present. A small proportion of the other hydrocarbons, however, remains undecomposed, and penetrates into the luminous zone, where it and the acetylene are both decomposed by the higher temperature attained, carbon is liberated, and this being, for a moment, heated to incandescence, gives luminosity to the flame.

An ordinary flat flame was now experimented with, the gases being withdrawn and analyzed in the same way as before.

Acetylene Formed in the Inner Zone of a Flat Flame from a No. 7 Bray Burner.

Portion of Flame.	Total Unsaturated Hydrocarbons. Per Cent.	Acetylene. Per Cent.	Other Unsaturated Hydrocarbons. Per Cent.
½ inch from top of burner	3.565	0.115	3.450
1½ inches from burner	2.063	1.303	0.760
1¾ " " "	1.393	1.133	0.260
2½ " " "	trace.	trace.	—

Showing that by the time the top of the non-luminous portion of the flame was reached over 81 per cent. of the hydrocarbon present had been converted into acetylene.

* Containing acetylene 0.035.

In such a flame luminosity commences just above the 1¾ inches above the burner; and, if luminosity is caused by acetylene, it is natural to ask why should it not have commenced at 1½ inches—a spot where the acetylene is present in larger quantity than at the higher point. The reason for this is that, in order to cause luminosity, a temperature must be obtained at which the acetylene is dissociated; and the point at which this takes place marks the commencement of luminosity. If this temperature is not attained, then the acetylene in the presence of oxygen burns away with a non-luminous flame, or, if no oxygen is present, polymerizes into a number of higher hydrocarbons. If, on the other hand, a sufficiently high temperature is reached to cause dissociation, the liberated carbon becomes incandescent, chiefly from its own combustion, but partly, also, from the combustion of the hydrogen liberated at the same time, and luminosity is the result.

The temperature needed to cause the dissociation of acetylene varies with the amount of dilution; the more diluted it is, the higher being the temperature necessary to break it up; whilst the larger the quantity of acetylene, the lower the temperature needed to cause its dissociation, and the smaller, therefore, the inner non-luminous zone of the flame.

In the flame from ordinary coal gas there is only from 1.1 to 1.3 per cent. of acetylene found in the inner zone, and, in this highly diluted condition, it requires a temperature of close upon 1,200° C. to break it up; whilst in other flames richer in hydrocarbons, and therefore richer in acetylene in the inner zone, the temperature required is not so high. For example:

	Flame of Coal Gas.	Flame of Paraffine Lamp
Percentage of acetylene	1.133	2.222
Temperature at commencement of luminous zone	1,267° C.	1,062° C.

The fact that unless the requisite temperature is reached the acetylene burns away with non-luminous combustion is, I think, clearly shown by the following experiment:

The flame of burning alcohol contains more than half the quantity of acetylene that a good gas flame contains, and yet the combustion is practically non luminous. If a dish containing some alcohol be placed under a bell jar, it burns with a flame having slightly luminous edges, and the temperature of the flame in this condition is 1,220° C. If now a glass plate be placed over the mouth of the bell jar for a few moments, the mixing of the products of combustion with the air lowers the rate of combustion, and the temperature of the flame falls to 1,050° C., the flame becoming perfectly non-luminous; whilst if oxygen be admitted to the bell-jar the combustion is increased and the temperature rapidly rises to 1,510° C., the flame becoming nearly as luminous as a coal gas flame, and depositing carbon on any cold surface held in it.

Again, if a small luminous gas flame be allowed to play upon the bottom of a platinum dish, so much heat is abstracted from the flame that the temperature falls below the point necessary to break up the acetylene, and the flame becomes non-luminous; whilst if the flame is allowed to remain in contact with the metal until the dish is red-hot, the luminosity returns, and the same effect may be produced by heating the interior of the dish with a blow-pipe flame. This experiment was devised by Heumann to show the effect of cooling on luminosity.

In every flame that I have examined which owes its luminosity to the presence of hydrocarbons, these bodies are converted into acetylene before luminosity commences in the flame, and every gaseous hydrocarbon which can by heat be made to deposit carbon is converted into acetylene before any deposition takes place.

Many of the hydrocarbons present in coal gas are known to give out heat during their decomposition, but probably the most endothermic of these compounds is the acetylene, Thomson having shown that no less than 55,010 units of heat are absorbed in the formation of 26 grains of acetylene, whilst only 10,880 disappear in the production of 28 grains of ethylene; and it is this which renders so easy its decomposition by heat, or as shown by Berthelot, even by detonation, into carbon and hydrogen.

The fact that acetylene is formed from the gaseous hydrocarbons present in illuminating gas prior to the emission of light does not, however, by itself, in any way disprove Frankland's theory that luminosity is due to very heavy hydrocarbon vapors and not to solid particles of carbon, as the well-known tendency of the acetylene to polymerize into higher bodies might be taken as an explanation of the presence of sufficiently dense hydrocarbons in a flame given by, say, pure ethylene.

In order to determine whether or no the acetylene formed in the earlier stages of the flame renders the flame luminous, by liberating carbon during dissociation, as required by Davy's theory, or by forming heavier hydrocarbons, a long series of experiments was made to ascertain the effect of heat upon the hydrocarbons present in coal gas,

and by specially devised apparatus to measure the actual temperature to which the gases were being heated, and to collect and analyze the resulting products.

In 1805, William Henry showed that when electric sparks are passed for some time through ethylene, the volume increased, and, although the action was far from complete, he was able to show that, at the temperature of the spark, all the ethylene which had disappeared had decomposed according to the equation—

$$C_2H_4 = C_2 + 2H_2,$$

the carbon being deposited on the poles and on the sides of the tube. The same thing was noticed by other observers, and in 1860, H. Buff and A. W. Hofmann showed that by heating ethylene by means of a platinum wire sealed into a tube containing the gas, and through which a powerful current was passing so as to raise it to redness, a deposition to carbon was produced, but no increase in volume, from which they conclude that the ethylene has decomposed into marsh gas and carbon—

$$C_2H_4 = C + CH_4,$$

an equation which has been reproduced in every text-book since that date. They then passed electric sparks through the gas, and in 25 minutes the volume of the gas was nearly doubled, and analysis showed that no marsh gas was present in the residual gas, which consisted of hydrogen, having, as they say, an unpleasant odor and burning with a slightly luminous flame.

No secondary products have been observed by anyone when passing electric sparks through ethylene, except De Wilde, who found small quantities of acetylene, but Berthelot has obtained traces of acetylene from carbon and hydrogen alone under these conditions. The experiments of Henry support the above conclusion, for although the decomposition was by no means complete, the only products obtained were carbon and hydrogen, together with undecomposed ethylene.

At temperatures lower than that of the electric arc the decomposition of ethylene is not so simple. This is indicated by the experiments of the Dutch chemists, of Grove, and of Buff and Hofmann, to which reference has been made. The latter chemists obtained marsh gas and carbon by use of a heated platinum wire. The experiments of Grove are not in strict accordance with this, but, as the spirals were not necessarily heated to the same temperature, perfect agreement could not be expected. The experiments indicate, however, that the next stage preceding complete separation is a decomposition into marsh gas, without the formation of any more complex products.

It has been noticed by various observers, amongst whom is Magnus, that at still lower temperatures much more complex actions take place, and at about 400° C. the heating of ethylene gives rise to liquid products, which Berthelot has shown not to be a single substance but a mixture of several liquids, among them benzine, styrene, and other liquids with higher boiling points. He found a trace of acetylene in the gaseous residue, and claimed that a large portion of ethane was formed, and on this basis supposed that the decomposition of ethylene by heat consists in a splitting of two molecules of ethylene into acetylene and ethane, and that the formation of liquid products is due to a subsequent condensation of the acetylene into more complex products.

Day also made a number of experiments upon the changes effected in ethylene by heating, and comes to the following conclusions:

1. Ethylene undergoes change by the action of heat at a temperature very much lower than has been observed in previous investigations.

2. The temperature at which ethylene begins to alter in constitution is about 350° C.

3. The change at this temperature consists in condensation without the formation of members of any series of hydrocarbons having a different percentage of carbon and hydrogen from ethylene. The change is slow, requiring at least 20 hours before it ceases, and it is not then complete.

4. If ethylene is heated to 400° for a sufficient length of time, it is entirely decomposed with formation of marsh gas, ethane, and liquid products.

I have been working upon the decompositions which ethylene undergoes, and I find that it decomposes in two ways, according to the method in which heat is applied. If the gas be kept sealed up in a glass tube for a very long time, at a temperature of 400° C., it decomposes into ethane, methane, and acetylene, the latter then polymerizing into the various compounds noticed by Berthelot; but that, on the other hand, if the ethylene is passed through a narrow tube heated to a higher temperature, so as to represent the changes which it would undergo on passing up through the non-luminous zone of a flame, the decompositions are somewhat different, no ethane being formed, but methane and acetylene.

Ethylene passed at the rate of 4 to 5 cc. per minute, through a tube 2 millimeters in internal diameter, undergoes no apparent change until the temperature rises to between 800° and 900° C., it then breaks down to methane and acetylene, and simultaneously with the formation of acetylene, heavy vapors appear which can be condensed, and in which benzine and naphthaline are conspicuous, as well as a heavy and highly fluorescent oil of high boiling point. Berthelot found that these substances were formed when acetylene was heated for some time at the temperature at which glass softens, and he also recognized among the products cinnamene C_8H_8, and retene $C_{18}H_{18}$, so that there seems very little doubt but that in passing the ethylene through a heated space in which the temperature does not rise above 900° C., methane and acetylene are first found, and the latter at once polymerizes into the heavier hydrocarbons. The amount of acetylene found in the products of the experiment rarely exceeds 1 per cent., as the polymerization occurs almost simultaneously with its formation, but the proportion of ethylene decomposed, and the amount of methane found in the products of decomposition, point to the initial action of heat at this temperature being

$$3C_2H_4 = 2\,(C_2H_2 + 2\,(CH_4).$$

On increasing the temperature from 900° C., slowly up to 1,000° C., the same action continues, no hydrogen appears in the products of decomposition, and no carbon is deposited but the formation of oil and solid hydrocarbons is more abundant. Between 1,000° and 1,100° C., a trace of hydrogen appears and a little carbon begins to deposit with the oil, this increasing with rise in temperature up to between 1,300° and 1,400° C., by which time all formation of oil has ceased. Carbon is deposited in larger quantities, and the residual gas consists of hydrogen with a little methane. The temperature at which oil disappears is about 1,200° C., and the proportion of acetylene formed at this temperature is larger than at any of the lower ones.

It is evident, therefore, that, if the temperature existing in the luminous portion of the flame exceeds 1,200° C., the luminosity cannot be due to such hydrocarbons as are formed from the acetylene, but that carbon will be present in abundance.

I have made several analyses of the carbon so deposited, and find that the hydrogen in it varies from 1 to 3 per cent.; and, as there is no fixed ratio, I think there is not the slightest foundation for imagining that it is in combination; indeed, Stein's work upon this point is fairly conclusive, and any one who has attempted to prepare hydrogen free carbon from sugar, or other similar body, will realize the intense power which freshly liberated carbon has of occluding and holding hydrogen.

Ethane, which is present in illuminating gas in larger proportion than is generally supposed, breaks up even below 800° C. into ethylene and hydrogen—

$$C_2H_6 = C_2H_4 + H_2.$$

and the ethylene behaves as before on increase of temperature. Methane, which is not only present in very large quantities in the original gas, but is also produced during the decomposition of the ethylene, is apparently unaffected by heat until a temperature of 1,000° C. is reached, when hydrogen and unsaturated hydrocarbons begin to appear in small traces. Acetylene, being the chief of these, this action continues and increases; so that, at about 1,500° C., considerable quantities of acetylene are formed, which break down to hydrogen and carbon. With methane, as with ethylene, the first trace of acetylene found in the products is also accompanied by the formation of oils and heavy condensable vapors. Methane is not so easily converted into acetylene as the other hydrocarbons, and requires a higher temperature to bring about the change; but the fact that it does do so at high temperatures fully explains the facts first observed by Dr. Percy Frankland and Mr. Lewis Thompson that, although methane, when burnt by itself, has but a very feeble power of illuminating, yet that, when used as a diluent of heavier hydrocarbons, it greatly increases the light-emitting power of the flame.

In order to apply the knowledge these experiments give of the changes taking place in the hydrocarbons present in coal gas during their flow through the heated channel in the interior of the flame, it is necessary to map out the temperature existing in a luminous flame, and the flat flame from a Bray burner—No. 7—lends itself conveniently to this purpose.

Using the Le Chatelier thermo-couple, described by Prof. Roberts-Austen at the last meeting of the British Association, and making only one short twist of the wires to give contact, and then coating them with hard glass, it is possible for nearly a minute to get the temperature in the portion of the flame in which the short twist is plunged, and if thin wires are used the loss by conduction is very small. Of course, if the part of the flame through which the glass-coated wires pass is at a

higher temperature than the portion around the twist, as the heat penetrates the glass it will give too high a reading, but for the first 30 or 40 seconds there is no fear of this.

With this arrangement I was able to map out the temperatures existing in the flat flame, in which I had traced out the changes taking place in the constituents of the gas, and I found that the temperature rapidly rose from 500° C., half an inch above the burner, to a little over 1,200° C. at the commencement of the luminous zone, the luminous edges having a temperature of 1,216° C., and these temperatures were further increased in the luminous zone until near the top of the flame 1,368° C. was reached. This at once gives us the secret of the luminosity. From the mouth of the jet and up to a temperature of 1,000° to 1,200° C. we have the formation of acetylene from the original hydrocarbons, but the moment the requisite temperature is reached by the combustion of the hydrogen and the carbon monoxide, the acetylene decomposes with a further rise of temperature, and the carbon, heated to incandescence, radiates heat and light.

In the experiments with the hydrocarbons the gases were passing through a heated space 6 inches long, kept at a constant temperature, in the flame they are passing through a space 1.75 inches long with a rapidly increasing temperature, so that instead of the acetylene becoming polymerized to any great extent, it reaches a temperature at which dissociation takes place almost immediately it is formed.

Experiments with hydrogen-borne benzine vapor show that at a temperature of 1,200° to 1,300° C., it is reconverted to acetylene, and this then at once breaks down to carbon and hydrogen, and the same happens with any other heavy vapors formed in the inner zone; and these bodies, formed probably in minute quantities by polymerization, together with any remaining methane, are reconverted into acetylene, and deposit their carbon as soon as the necessary temperature is reached, and this supplies a fresh quantity of carbon particles to the upper portion of the luminous zone, and so increase its size.

The careful analyses of Hilgard, Landolt, and Blochmann, made to determine the interactions taking place in various flames, are in their main features in close accordance with a long series of analyses of the flame gases which I have made; and one of the most striking features of these is the comparatively slow rate at which the heavy hydrocarbons disappear, as compared with the other constituents of the original gas. This I find to be chiefly due to diffusion, which causes the hydrogen and methane to find their way to the outer skin of the flame first, and it is these bodies, therefore, which bear the brunt of the earlier combustion, and yield the heat which bakes the heavy hydrocarbons, ascending straight upwards from the burner, into acetylene.

If three concentric tubes be placed half an inch above an open tube from which coal gas is issuing, and the gas from each is withdrawn and analyzed, it will be found that, on comparing them with the original gas, the action is most marked; the gas in the outer tube being practically a mixture of air with hydrogen, whilst in the inner tube the unsaturated hydrocarbons have risen from 3.56 to 4.53.

All analyses of the flame gases also show that the hydrogen burns first, and that next in rapidity of burning is the methane; and Prof. Smithells advances the theory that, in the incomplete combustion taking place in the flame the hydrocarbons burn to carbon monoxide and hydrogen.

As has already been shown, the proportion of heavy hydrocarbons consumed before conversion into acetylene, and then dissociation into carbon and hydrogen, is very small, and the principal hydrocarbon undergoing combustion in the flame is methane. The analyses of Landolt, Hilgard, Blochmann, myself and Smithells all show that a large increase in the carbon monoxide undoubtedly does take place, the higher one ascends in the flame, until the luminous portion is reached; and also it is probable, from the same analyses, that hydrogen is generated by some action in the outer layer of combustion, as, in spite of its rapid combustion at the base of the flame, as shown by the large percentage of water vapor formed there, it keeps reappearing for some little distance up the flame, and it is to explain the joint appearance of carbon and hydrogen that Prof. Smithells brings forward his theory that carbon burns to carbon monoxide, setting free the hydrogen from the hydrocarbons.

There is not the slightest doubt, from the work done by Dalton, Blochmann, E. von Meyer and Dixon, that, if you explode together gaseous hydrocarbons with a limited supply of oxygen, you obtain carbon monoxide and hydrogen; and it is also shown by H. H. Baker's experiments that carbon burns first to carbon monoxide; but I fail to see that any such theory is necessary to explain the actions taking place in a flame. If we analyze the gases present in a flame three-quarters of an inch above the burner, which is about the point at which increase of carbon monoxide commences, although it is not marked until 1½ inches up the flame, we find that, in the outer zone of the flame, we have—

Water vapor.....	24.65 per cent.
Methane.....	8.35 "

A little deeper in the flame we get—

Water vapor.....	17.94 per cent.
Methane.....	21.51 "

And from this point up to 1½ inches you have the temperature rapidly rising from 751° C. to 1,100° C.; and it is a well-known fact that, if heavy hydrocarbons and water vapor are heated together, they yield carbon monoxide and hydrogen; indeed, it is the most expensive method of making water gas, and wrecked one process for the manufacture of illuminating water gas. And one would expect the same thing to happen when the methane and water vapor are heated to this temperature.

In order to try if this were so, methane was passed through water just below the boiling point, and then through a tube heated to 1,000° C., the resulting gases being then analyzed, when it was found that the methane and water vapor had interacted to form hydrogen, carbon monoxide, and carbon dioxide; and I should think that this is a far more likely cause of the effects produced in the flame.

Taking the facts which I have now laid before you, we may, I think fairly fully explain the actions that take place in the flame and lead to luminosity. As the gas leaves the jet, the hydrogen rapidly diffuses to the outer edge of the flame and burns, the methane doing the same but rather more slowly. The combustion of these gases raises the temperature 500° C. in the first ½ inch, whilst before another ½ inch has been traversed 1,000° C. is reached, and the chemical changes in the hydrocarbons are progressing rapidly, the unsaturated hydrocarbons and higher members of the saturated hydrocarbons being rapidly converted into acetylene. If the temperature of the flame were not allowed to rise above 1,000° C., this acetylene would be nearly all polymerized into benzine, naphthaline, diphenyl, and other complex bodies, which would be slowly burnt up without liberation of carbon, and a non-luminous flame would result. In the case of a gas flame, however, instead of remaining at 1,000° C., the temperature rapidly rises to 1,200° C., with the result that instead of polymerizing into more complex bodies most of the acetylene formed, at once splits up into carbon and hydrogen, and the former heated to incandescence by combustion gives the luminosity. It is the attainment of this temperature that marks the limit of the non-luminous zone. If this were the only action, however, the luminous zone would be very short. The bodies, however, formed from the acetylene before 1,200° C. was reached, and the methane, of which some still remains unburnt, are converted into acetylene at a still higher temperature, *i. e.*, 1,300° C., and this being reached near the top of the luminous zone, yields a fresh supply of carbon, and so increases the height of the light-yielding portion of the flame.

In producing the luminous flame, therefore, there are two main factors to be observed, first, to use such compounds as shall be most easily converted into acetylene, and secondly, to attain as quickly as possible as high a temperature as practicable.

SPECIAL ENGLISH CORRESPONDENCE.

COMMUNICATED BY NORTON H. HUMPHRYS.

SALISBURY, January 10, 1893.

The Weather.—"You Scoundrel.—Coal and Labor During 1892.—*The Market for Tar and Sulphate.*

The advent of Christmastide has brought with it a complete change in the state of the weather. Up to about the 23d ult. we experienced no cold worth speaking of; but at that time a hard frost commenced, which continued without intermission up to the present time. Contrary to expectation, we have experienced what is called a "regular old-fashioned Christmas," which means fine, clear, and frosty weather. I need not add that this change is hailed with satisfaction from a gas man's point of view. It has fully illustrated in most districts a point to which I have previously drawn attention—that the conditions of gas supply are different to those which prevailed 20 years ago. Then we looked upon foggy, or dark, cloudy weather, as likely to put the heaviest strain upon our gas producing plant; now it is more a question of temperature. Although the hours of darkness remained about the same, it has been the general experience that, as the temperature went down, the rate of consumption of gas went up.

The cold weather is also welcomed as increasing the demand for coke,

which was accumulating to an unsatisfactory extent. But now the stock diminishes each day, and it is a pleasure to go into the yard and see the space, occupied a month ago with a mountain of coke, crowded with vehicles of all sorts and sizes, from a sugar box on wheels or a child's perambulator, up to a 4-horse wagon, awaiting their turn to be loaded.

The frost, of course, has dealt roughly with the street lamp services, and any other exposed pipes, producing the usual stock of complaints, and frequent visits from individuals who persist in regarding the fact that their service pipe is half blocked with ice as a vile subterfuge for concealing the use of inferior coal at the works. It interferes with the action of the purifying apparatus, where such is not properly housed, and with the gasholders; but for all that, it is a welcome visitor from the standpoint of the gas stockholder.

"You scoundrel!" The scene was a court of justice. The gentleman who muttered the above-named unparliamentary language was a magistrate's clerk. And the individual for whose ear alone it was intended was a prisoner who had just been condemned by the representatives of the Queen to hand over a sum of money to the clerk aforesaid, in consideration of having been found drunk and incapable on the previous evening, and creating a disturbance in the streets. In the earlier part of the day, and before beclouding his intellect by these excesses, he had devoted himself to "turning an honest penny," but in a far from honest way. He was a gas burner man. Calling upon a gas consumer, he opened up a conversation about the impurities in gas. Lighting one of the burners in use, he asked permission to fit one of his own, in order to compare the two. Having both flames in operation, he produced a penny and held it in the flame of the old and established burner, with the result that it was coated with soot. This was proof of the impurity (?) in the gas. The coin was then wiped and held in the flame from the new and improved appliance, when it remained quite clean, illustrating the purifying action. Amongst others, the magistrate's clerk had been waited on, and was so impressed by this practical proof that he purchased a dozen of the improved purifying burners and took them home. With much complacency he proceeded to give a practical demonstration for the benefit of his wife and family, but to his disappointment found that the charm had vanished and that a penny held in the flame evolved from one of his purchases was covered with soot. He consulted a philosophical friend on the matter, who explained to him that gas flames will deposit soot on a cold metal surface, and that the secret of getting no deposit was to get the penny well warmed, and advised him the next time the gas burner man comes to have the penny put in the patent flame first. And this is the reason why he muttered, as he pocketed with extra satisfaction the prisoner's fine, those words that commence this paragraph.

The year that has just closed has witnessed some remarkable features both in regard to coal and to labor. In both these artificial means have been resorted to with a view of obtaining the highest possible prices. The coal merchants, and especially the coal miners, have been fighting desperately against a falling market, and directing special efforts in the instance of gas coals. Early in the year a novel expedient was tried. A large number of collieries, representing some 400,000 workmen, were absolutely closed for a week, with the object of reducing stocks and preventing any excess of supply over demand. In the Durham district a strike took place extending over three months, the miners refusing to accept any reduction in the rate of wages. These expedients certainly reduced stocks, but they led to two other matters that could scarcely have been contemplated by the promoters of these movements. They drove some of the export trade away from the country, a portion being permanently lost, and they led to the importation of foreign coal. There is a common saying, "It is no use carrying coals to Newcastle," but matters were within measurable distance of this feat being practically accomplished. The evil was not confined to coal alone, but extended to the iron trade and other manufacturing industries that are dependent upon the coal supply. The actual result was not only no advantage to the parties primarily concerned, but an injury to outsiders, the nature and extent of which can scarcely be accurately defined. Notwithstanding these endeavors, the prices of gas coals have declined and are now about 50 cents per ton under the high rates that prevailed during 1891. A noticeable feature of the year, and one that has some bearing upon this question, is the advance that has been made in the use of petroleum on gas works. Many of the first magnitude works are now erecting tanks for the storage of fluid hydrocarbons, showing that these substances are now permanently adopted as gas making material.

The disputes that were a marked feature during 1891, on the matter of labor questions, have been less prominent during 1892. The fair and liberal spirit with which gas companies have met their workmen has been appreciated, and has led the latter to consider whether, after all, the master is not as good a friend as the outside paid agitator. His thoughts have been stimulated in this direction by the conspicuous failure on the part of the laborers' unions to provide adequate relief funds for the sustenance of the unfortunate men whom they induced to lay down their tools. Attention has been directed to the general question of day laborers and their earnings, and a Government Commission has been giving careful attention to the subject. Mr. George Livesey was a member of that Commission, and the principal witness in connection with the gas industry was Mr. W. A. Valon, President of the Gas Institute, who presented a very voluminous collection of statistics relating to the nature of the employment and the rates of wages paid to all classes of workmen on gas works. The aggressive spirit on the part of the men, however, occasionally reappears. In many works it is the custom to pay double time on Christmas Day and Good Friday and one and a half time on Sundays. At a works in the north of England the workmen demanded 2½ time, 2½ days' pay for one day's work, for Christmas Day, because it happened to fall on Sunday this year, and debated for some time the advisability of striking in order to force their demand. They decided to continue working, pending the consideration of the matter.

Tar and sulphate of ammonia still remain at a low figure, and without prospect of immediate improvement. And with this in view, at a time when the smallest contribution towards the income side of the revenue account would be most thankfully received, it is tantalizing to read so much in our scientific periodical literature about the numerous and valuable products that are obtained from coal tar, or about the wonderful manurial properties possessed by sulphate of ammonia. "What care I how fair she be, if she be not fair for me," sang the poet. And so say we about tar and sulphate. What difference does it make to managers of gas works if dyes, and artificial sugars, and flavoring essences can be extracted from tar, when they cannot realize more than $2.40 to $3.60 per ton for it, and when many find it more valuable as a fuel in the retort house; or if sulphate of ammonia will enable unheard of quantities of potatoes or turnips to be raised per acre of ground, when the financial barometer, instead of rising, is inclined towards falling. Nor are their feelings soothed by the fact that, in the case of sulphate, at any rate, the low prices are largely due to the operations of speculators who produce an artificial fall in price to suit their own purposes. Their endeavors have been so far successful that the average market value of sulphate during 1892 has been lower than in any previous year, and less than half that which was prevalent 10 years ago. In that period the quantity produced per annum has about doubled itself, but it must not be supposed that this is a case of overproduction. On the contrary, the supply is only about equal to the demand. The total quantity made during 1892 is estimated as 157,000 tons, or something more than half the total production of the world, and of this 112,000 tons came from gas works, 28,000 from shale works, and the remainder from iron and coke works. Only about 43,500 tons were consumed at home, including both agricultural and chemical purposes, the remainder being exported to the Continent. As the consumption of sulphate for chemical purposes is something considerable, it would appear that there is room for further developments in the quantity taken by our home agriculturists, who are importing enormous quantities of nitrate of soda, guano and such like nitrogenous manures from foreign parts. But somehow many of them seem to treat sulphate as Macbeth did his physic, and will have none of it. Dr. Dreyfus, in a paper read before the Society of Chemical Industry, ascribes the low value of benzine, anthracene and other tar products to increased production. In many parts of the Continent the utilization of the gases from coke ovens has become a regular practice, and the production both of tar and ammonia from this source is very large. So that the prospects as to the future value of these residuals are not encouraging. Evidently the best course for gas managers to adopt is to dir ct their attention to the encouragement of local demands, and to the disposal of as much tar and ammonia as possible in their own districts. This is a question about which there has been a great deal of talk, but little practical result, speaking for my own country only, of course.

The Oil and Gas Regions of Ohio.

Mr. John Gould, writing of the oil and gas well districts of Ohio, says that these black swamp lands of Ohio were the 1,200 feet covering of an oil stratum, and across the State from northeast to southwest was to be discovered a gas belt that would be a world's wonder, no one had ever dreamed of, and this discovery, a few years since, the mad rush of

speculators, and the tide of adventurers who are also seeking their Eldorado, have had a wonderful effect upon the agriculture of the western counties of the State. The number of wells, both of gas and oil, that have been put down in Western Ohio is past computing, and as each one represents an outlay of from $2,000 to $5,000 for derrick, engine, housing, piping, and labor, some ecomomists put the outlay at a figure actually above the income from the sale of the oil. It is also to be doubted if the farmers, except in individual instances, have had their actual wealth enhanced by the discovery of oil; not but that the farmers receive the money for the ground lease and royalty, but assuming that these wells would be a lasting source of income, hosts of these men have in turn become oil speculators and well developers, and the abandoned wells and dry holes tell why oil is not always a source of wealth or profitable investment.

A day of observation among the wells is not without interest, and may possibly awaken a moment's attention on the part of your readers. These wells are usually in clusters, varying in number from 6 to 100, and as a rule are not far from 1,200 feet in depth. The huge derricks above them are not far from 60 feet in height, resembling a windmill tower. The wells are cased below the water line with a 5 inch iron tubing; inside this are the 2 inch pump tubes. The well is provided with a small engine, although the steam is furnished from a cental boiler house that supplies power for from 3 to 8 wells. The steam pipe to the wells, that may be 10 or 150 rods away, is put in a 6 inch square wooden conduit box, elevated about two feet from the ground. From each well a return ½ inch gas pipe is carried to the furnaces of the boilers, so that no fuel but gas is used. Nearly all the wells produce a little gas, which is thus utilized, making a steady, uniform fire; and besides, this plan enables the engineer not only to manage the boiler house, but also to look after all the wells connected with it.

The wells vary greatly in productiveness, and that a well is a good producer is no sign that another, six rods away, will be worth pumping, or that the lasting qualities of one well give any assurance that its neighbor will last beyond the time required to pump its "head" off. The oil in this region seems to be found in "pockets," that underlie tracts of land from a few acres to whole sections and the greater part of a township. The county has been all drilled over by the prospectors, and derrick ruins in every direction attest that it costs money to find money, and that fortunes are lost quite as often as found.

The oil product has greatly lessened, and, with few exceptions, a 30-barrel well is now counted a good one, though a well is pumped until it gets down to a one or two "barreler," when it is "shot," and then if the flow is not increased, the derrick is taken down, the pumps taken up, and the casing drawn with powerful "jacks," the hole plugged, and our farmer's source of royalty is at an end, unless he has a number of wells upon his farm. Many farmers will lease only a few acres to a company, and so may have two or even three oil companies producing upon his farm. When a good well is struck, the aim of other companies is to lease up as close to the well as possible, and put down wells all about it and thus assist in pumping out a territory as soon as steam pumps will elevate it, to prevent the other man or company from making a "mint." These rival wells are not always a success, and a poor well beside a good one is not a rare thing.

Farmers are paid a pretty uniform price of $2 per acre ground lease and one-sixth of all the oil pumped, and those who were thus content, and wisely used their royalties, and kept right on farming, have reason to congratulate themselves, while others are softly repeating the old refrain, "It might have been" otherwise.

Each and all of these wells are connected with the Buckeye pipe line, and the oil is first pumped into a tank at the well. At certain times the pipe line companies' agent visits the well, measures the oil in the tank, gives a "scrip" for it, and connection is made with the main line, for all wells have a small pipe to the main pipe, that is operated by large pumping engines, with compound pumps, that have a capacity of forcing from 5,000 to 15,000 barrels of oil through the lines in 24 hours, and these mains are connected with the lines of the Standard Oil Company, that extend to Chicago, Buffalo, Cleveland, and New York City, so that when the oil leaves a well tank there is no knowing where it may be four days after. The man who takes the pipe line oil receipt, or scrip, takes it to the pipe line company, who cash it at the going price of oil—now 43 cents—or sells it to an oil broker, and it quickly becomes a factor in the oil exchange, to bull and bear the oil market.

The "shooting" of a well is an interesting operation. The pumps are pulled up, long 3 inch tin cans of nitro-glycerine are carefully let down to the bottom of the well, often 100 quarts in all, and then a little iron go devil is dropped down into the well, which, striking the top can, explodes it, and all the rest for that matter. There is a faint explosion heard, the earth gives a pulsation, and oil and gas may as a result spurt into the air in a column or it may not, and the well may freshen up or it may prove permanently dry, in which event the derrick is torn down and the well pulled up.

The gas fields are dotted here and there through the oil territory, though both are often found in paying quantities close together, but great as was the amount of gas and so wasteful were its discoverers that probably not over one-fourth of the gas once found can be coaxed from the ground at present, and where gas was used not only to light and warm buildings and furnish fuel for all kinds of manufacturing purposes, so low has the pressure become that wood, coal, and coal oil are now in active demand by a majority of those who once used it almost exclusively.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

Mr. E. C. Jones, of the San Francisco (Cal.) Gas Light Company, writing from that city, under date of January 16th, says: Dear Journal: In reading your issue of the 9th inst., I noticed in an article by Mr. Frederic Egner, entitled "An Unpopular Subject Popularly Treated," the following: "Interested promoters sometimes convince ignorant investors that they can produce something out of nothing. In the gas business this deception is usually accomplished by means of a little instrument known as the Jones Jet Photometer. With it there is little difficulty in making 12 candle power gas appear to be any power which the height and graduation of the chimney admit." At the beginning of its fourteenth year of success, with thousands of jet photometers in use, at all the most important gas manufacturing plants in the world, this is the first time I have been called upon to say anything in its defense, or rather in defense of the honest gas engineers who daily use it. I had the pleasure of making the first 2,000 of these instruments that were placed upon the market, with my own hands, and each was carefully compared with a standard adjusted by Bunsen bar tests. During the years I made them many of them were returned for repairs and readjustment, and among them I never found a photometer that had been tampered with to make it flatter the quality of the gas, but in all cases they had become clogged by careless use and registered low. The allusion to my jet photometer reminds me of an old story told of Daniel O'Connell, while a student at a school in Cork. One morning, while crossing the college yard, he came across a number of fellow students, who had captured a tale bearer and were about to duck him at the pump. On seeing O'Connell, who was very popular, they shouted, "What shall we do with him, Dan?" He replied, in his usual quiet way, "Don't nail his ear to the pump, gentlemen." This negative suggestion was quickly carried out and the tale bearer had his ear nailed to the pump. Now, I trust that no unprincipled party will avail himself of Mr. Egner's suggestion and tamper with my very carefully adjusted photometer for dishonest purposes; for it is as capable of disarrangement as any other piece of gas apparatus, or a Waltham watch.

The proprietors of the Waltham (Mass.) Gas Light Company have ordered that the net rate per 1,000 cubic feet be reduced to $1.80.

An interesting legal decision on appeal recently reported in the Boston papers is that entitled William O'Maley versus the South Boston Gas Light Company, which was an action of tort under Chapter 270 of the Acts of 1887, for personal injuries. The plaintiff was an employee of the defendant, and had been such for 15 years previous to the time of the accident, which occurred on December 23, 1890. He was wheeling coal upon an elevated stage or runway, and fell from the latter, by reason, he alleged, of the negligence of the defendant in failing to provide a proper safeguard in the shape of a raised handrail or other suitable fender. The presiding judge in the court below ruled that the plaintiff could not recover and ordered the jury to find a verdict for defendant. To this plaintiff excepted and appealed, whereupon the higher court, in an opinion written by Judge Knowlton, says: "We have no doubt that anyone may expressly contract to take the obvious risks of danger from inferior or defective machinery as well since the enactment of this statute (employers' liability act) as before. Whether he knows or appreciates the particulars of the danger is immaterial, if he knows there is danger and expressly contracts in regard to it without caring to know the particulars, and he must be deemed to encounter it willingly. The same reason applies equally where the employee, without any express stipulation in regard to risks, enters a service which by reason of the obvious condition of the ways, works and machinery, involves peculiar dangers. Such a contract is implied, as ought to be implied, from the situation and dealings of the parties, and it has the same

effect if expressly made. In the present case, the plaintiff when he made the contract knew and fully appreciated the dangers to which he was about to expose himself, for they were obvious, and he had been accustomed to work on the runs from time to time for 15 years, during which period they had remained unchanged. We are of opinion that he impliedly contracted to work on the runs as they were, and if they can be considered defective the defect is not within the description in the Statute of 1887, Chapter 270, Section 1, inasmuch as the defendant owed him no duty in regard to it, and plaintiff cannot say that its continued existence was owing to the negligence of his employer. The exceptions are overruled." Mr. J. P. Barlow had charge of the case for plaintiff, and defendant's interests were looked after by Messrs. C. P. Greenough and J. P. Pamenter.

THE MESSRS. WILBRAHAM BROTHERS, whose exhausters, blowers and pumps have won such deserved recognition at the hands of the gas industry, have disposed of their business to the Wilbraham-Baker Blower Company, a corporation organized under the laws of New Jersey. The manufacture of the Company's specialties will for the present be carried on at the old shops, No. 2518 Frankford avenue, Philadelphia, or until the new manufacturing plant at Trenton Junction is completed and equipped. The officers elected by the Wilbraham-Baker Company, at a meeting held at Trenton Junction, on the 9th inst., are as follows: President, John W. Wilbraham; Secretary and Treasurer, John S. Wilbraham; Asst. Secretary and Treasurer, Thomas C. Wilbraham.

MR. A. H. RAUCH, Superintendent of the Bethlehem (Pa.) Gas Company, writing to us under date of the 23d inst., says: "Dear JOURNAL—In this severe winter we were again obliged to cover the water in our holder with a film of oil, to prevent hoar frost in the pipes, as far as the evaporation of that water surface is concerned. We have passed quite a number of winters safely without this, but were caught again by the persistent cold before applying the preventive."

WE are pleased to report that Mr. F. D. Page, whose persuasive powers as collector are much appreciated by the Fitchburg (Mass.) Gas and Electric Company, is rapidly recovering from the severe illness that prostrated him some weeks ago.

MR. JOHN W. HATSTAT, formerly of New Haven, has been appointed works foreman of the Hartford City Gas Light Company.

AND this mention leads to the note that the Directors of the Hartford Company, whose election at the recent annual meeting of the shareholders has been reported in the JOURNAL, have perfected the following organization: President, Hon. James L. Howard; Treasurer and General Manager, General John P. Harbison; Sec., Mr. Thomas Evans.

"OBSERVER" forwards the following from Glouscester, Mass.: "At a meeting of the Directors of the Gloucester Gas Light Company, the Clerk of the corporation, in announcing the vacancy caused by the death of the President, feelingly spoke of the deceased as not only a just and consistent official, but as a companionable and generous friend. Several of the Directors having voiced similar sentiments, Mr. Bradford offered the following set tribute: The Directors of the Gloucester Gas Light Company desire to put upon record the value of the services of the late Frederick Hussey Odiorne, of Malden, to this Company. He has been a Director from June, 1869, and President of the Company from June, 1876, to date of death, January 3, 1893, during which time his advice and assistance to the officers of this Company have been of great value, from his intimate knowledge of matters connected with the gas business, and in his death we feel the loss not only of a valuable adviser, but also of a very pleasant companion and friend.

"*Voted*, That the tribute given to the worth of Mr. Odiorne as officer and friend be placed upon record, and a copy sent to his family, with our sympathy."

IN further mention of the affairs of the Gloucester Company we may add that the vacancy in the Board of Directors has been filled by the election of Mr. John A. Coffin, whose years of faithful service as Purchasing Agent and Superintendent have stood the Company in good stead. The Board then elected Mr. George R. Bradford to the Presidency.

A GLIMMER of reason seems to have agitated the Common Council of Rochester, N. Y., about mid-January, at which time they agreed to indorse the report of the Lamp Committee of Council, which we append: "To the Honorable, the Common Council—Gentlemen: Your Lamp Committee, to whom was referred the proposition to discontinue the incandescent system now in use in the western part of the city and substitute therefor the arc system, submits the following as its report thereon: Your Committee has investigated the subject and conferred with the City Electrician, and from its investigation it appears that the incandescent lights have been gradually reduced in number from time to time, until now there are but comparatively few in use, and those are scattered over quite a large territory. It has been suggested that they be entirely abandoned and the arc system substituted. In conferring with the Rochester Gas and Electric Company in relation to the change, it was at first suggested that the Company, under its contract with the city, would be entitled to compensation for taking down and removing the system, but your Committee, by insisting that the number of lights would be somewhat increased proportionately, and that the expense of maintaining them would be slightly increased, has succeeded in prevailing on the Company to abandon its claim for remuneration for making the change, and to agree to make the change without expense. Your Committee, therefore, recommends that the Rochester Gas and Electric Company be authorized to discontinue the incandescent electric lighting system wherever the same is now in public use, and to substitute therefor the arc system, upon the express condition that no charge be made for making such change. The increase in the expense of lighting the territory now lit by the incandescent system will be $4.05 per night, but as the incandescent system has not been giving satisfaction at any time since its introduction, and especially since the number of incandescent lights has been so materially reduced, it is believed that the city will get very much better returns from the money paid out by the use of the arc system."

THE Committee, no doubt, could have uttered a much stronger indictment anent the incapacity of the incandescent electric lamps, as these were maintained at Rochester—and, for that matter, in any other part of the country where they have been tried—but as the indictment was sufficiently binding to throw the service out of use, a few words more would not have counted in the result. The general belief is that the incandescent electric lamp as an aid to the lighting of streets is utterly inadequate.

THE City Electrician of Spokane, Wash., in a report made early this month to the local Board of Public Works, calls attention to the fact that the arc lamps (rated to be of 2,000 candle power) on the streets are very much under the lighting value requirements of the contract. The average of six tests (in all, 80 lamps were tested) gave a lighting power of 924 candles.

WE have to report that at the annual meeting of the shareholders of the Laclede Gas Company, of St. Louis, Mo., two changes were made in the Board of Directors, the "retiring" members being Messrs. J. D. Thompson and George D. Capen. The Board as now constituted is as follows: Messrs. James Campbell, J. H. Lionberger, J. C. Van Blarcom, J. H. Conn., Frederick Ebey, J. H. Parmlee, Peter Nicholson and E. Mc Millin. The new members are Messrs. Campbell and Nicholson. We regret very much the retirement of Mr. Thompson, which no doubt was due to the "necessities of the situation," but we have unbounded satisfaction in saying that Mr. Thompson was never recreant to any trust that was ever reposed in him; further, that he answered well to the call when the real Laclede Company was in need of staunch and loyal executives.

MR. HOAR, a member of the Massachusetts House of Representatives, has introduced the following bill, which is entitled an Act to regulate the price charged for gas and to regulate the candle power of the same:

"Section I.—No person or persons, corporation or corporations, now or hereafter chartered for the purpose of making or selling gas for illuminating, cooking, heating or other purposes for which gas may be used, in cities having according to the last census a population of 200,000 inhabitants or over, shall charge more than $1 per 1,000 cubic for said gas, and said gas shall be of not less than 25 candle power.

"Section II.—It shall be the duty of the Gas Commissioners, within 10 days after the passage of this Act, to inform any person or persons, corporation or corporations making or selling gas for any of the aforesaid purposes, in any city in this commonwealth now or hereafter coming under the provisions of this Act, of the requirements of this Act.

"Section III.—Any person or persons, corporation or corporations, refusing or neglecting to conform to the requirements of this Act, for a period of 30 days after having been notified by the aforesaid Gas Commissioners, shall forfeit all franchises, rights, privileges, charter or charters, granted or to be granted by this commonwealth; and the Attorney General is hereby authorized and directed to appeal to the courts for an injunction restraining any said person or persons, corpor-

ation or corporations, from carrying on business in any city now or hereafter coming within the provisions of this Act.

"Section IV.—All Acts or parts of Acts inconsistent herewith are hereby repealed.

"Section V.—This Act shall take effect on its passage."

A BOSTON daily, in commenting on this measure, which seems to us to be inimical to the continued good working of the State Board of Gas and Electric Light Commissioners, remarks that Mr. Hoar evidently means business, and adds: "Mr. Hoar is satisfied that a mere money penalty for breaking or evading the law would be of no effect. The gas companies are making so much money that fines would amount to nothing. He would, therefore, impose the severest penalty possible for non-obedience, and take away the charter and franchises of such companies as refuse to sell 25 candle power gas for $1 per 1,000 cubic feet."

THE bill, meanwhile, is in the hands of the Committee on Manufactures, to whom it was referred, and we doubt not that in due season the Committee will give hearing to the matter.

"AT an early hour of January 19th an explosion startled the drowsy residents of that section of the city of Utica, N. Y., in which is located the plant of the Equitable Gas and Electric Light Company. A brilliant illumination followed the explosion, and in a few minutes the engines of the Fire Department were on their way to the foot of Washington street. One of the first to reach the field of danger was General Manager Pinkney, of the Company, who skilfully, and with somewhat reckless disregard of personal consequences, directed the attempts of the works' hands and the firemen to the extinguishing of the flames, which had their seat in volumes of gas that were issuing from a ruined wall of the station meter house. Subsequent investigation—the flames were speedily quelled—showed that the explosion originated in the meter room, and its force was sufficient to throw down one of the walls thereof. The wall in falling fractured a drip pump, which fracture permitted the gas to pass back from one of the holders. When the fire was put out, the fractured pipes were speedily plugged, in the effecting of which Mr. Pinkney was prostrated by the gas fumes, but quick measures for his relief were taken with satisfactorily prompt results. The purifying house sustained slight damage from the falling meter house wall, but, all told, the Company is to be congratulated on its lucky emerging from an accident that might have resulted most disastrously. The monetary loss is comparatively small, and the operation of gas making was not seriously interrupted.—MOHAWK."

AT the annual meeting of the Capital Gas Company, of Sacramento, Cal., the following result was reached: Directors, Messrs. Frank Miller, Benjamin Welch, John McKee, F. L. Woods, B. U. Steinmann, Oliver Eldredge and C. H. Cummings; President, B. U. Steinmann; Vice-President, Oliver Eldredge; Secretary and Treasurer, C. H. Cummings.

THE proprietors of the Chelsea (Mass.) Gas Light Company have declared a semi-annual dividend of 3 per cent. Plant improvements will be made at this point this spring.

THE rates charged by the Citizens Electric Light and Power Company, of Fremont, O., are as follows: 16 candle power lamps, on a lighting service seven nights in the week, commencing at dusk and terminating at 2 A.M.: 3 to 5 lamps, 65 cents each per month; 6 to 10 lamps, 60 cents; 11 to 15 lamps, 55 cents; 16 to 25 lamps, 50 cents; 26 to 50 lamps, 45 cents. A lighting service for 5 nights in the week, from dusk to 10 P. M., and to midnight on Saturdays: 3 to 5 lamps, 60 cents each per month; 6 to 10 lamps, 55 cents; 11 to 15 lamps, 50 cents; 16 to 25 lamps, 45 cents; 26 to 50 lamps, 40 cents. For additional lamps a special contract is made—it should be added that the above schedule applies to what the Company denominates "commercial lighting." The "domestic rates" are as follows—the lighting hours, however, to be all night and every night: 3 lamps, 60 cents each per month; 5 lamps, 55 cents; 6 lamps, 50 cents; 7 lamps, 45 cents: 8 to 10 lamps, 40 cents; and $2 per annum for each additional lamp. The Company furnishes free of charge the original outfit for lighting, "consisting of lamps, key sockets, safety cutouts, wires, pendant cords, together with all cleat work." Extra charges are the following: Moulded work, 40 cents per lamp; concealed work, $1 per lamp; attachments to existing gas fixtures, 70 cents per lamp; gang switches, from $2 to $5, according to size. All shades, shade holders, brackets, electroliers, and special fixtures are at the expense of the customer. The Company makes all necessary connections from its main line to the house, free of cost, but all connections and appliances from that point are at the cost of the users. The first outfit of lamps is furnished free of charge, and upon the surrender of a defective lamp, the Company will replace the same without charge, provided the said lamp has not been burning to exceed 600 hours. All other lamp renewals are to be at the consumer's expense. The Company also reserves the right to substitute a meter measurement for the contract service, the charge therefor to be "1 cent per hour for each 16-candle power lamp, or its equivalent." Messrs. Ford & Plagman are the Managers of the Company, and we submit that, under the operation of the above schedules, the concern ought to be soon in the hands of the sheriff.

AT the annual meeting of the Newburyport (Mass.) Gas and Electric Light Company the following officers were chosen: Directors, A. H. Reed, W. H. Swasey, E. F. Stone, L. B. Cushing, Eben Sumner, T. C. Simpson and W. R. Johnson; President, E. F. Stone; Treasurer and Clerk, D. D. Tilton; Auditor, W. E. Chase.

THE City Council, of Manchester, Va., has finally adopted an ordinance awarding to the Southern Fuel and Gas Company, of Richmond, Va., the right to construct and operate a gas works in that city. Under its provisions the Company binds itself to furnish gas of such "a quality and character as will give lights for at least 20 candle power per light when using the standard gauge of aperture for gas burners"—whatever that may mean. As to selling rates, the following is the agreement: Ordinary consumers, 5,000 cubic feet or less per month, 50 cents per 1,000; 5,000 to 10,000, 45 cents; 10,000 to 20,000, 40 cents; 20,000 to 50,000, 30 cents; over 50,000 cubic feet per month, "special contracts may be made, not to exceed, however, 30 cents per 1,000 cubic feet." The Company may not charge the city to exceed 20 cents per 1,000 for gas used for lighting and heating the public buildings; and the city may require the Company to furnish gas for lighting the streets at a rate, for each and all night lighting, not to exceed $3 per month per lamp. The ordinance further provides that the construction of the plant must be commenced at least 90 days after the signing of the agreement, and that the works shall be in readiness to manufacture gas, and supply the same "within one year from the commencement of the construction thereof." With all due respect to the Manchester Council and to the proprietors of the Company we fear that those Utopian gas rates will not prevail in Manchester for many a day unless it be that both authorities and proprietors arrange it between them for the liberal maintenance of public street lamps, to be kept up at a charge of $3 per month each. There is money in that part of the scheme, but only disappointment and debt in the other section of it.

THE schedule rate of the Tucson (Arizona) Electric Light Company is as follows:

Each 16 c. p. light per month, from dusk until 9 P. M.,							$1.50
"	"	"	"	"	" 11	"	1.65
"	"	"	"	"	" 12	"	1.85
"	"	"	"	"	" all night,		3.50

This tariff applies on "commercial lighting" in instances where 5 lamps or less are used. Places such as public halls, hotels and the like may obtain "special contracts." Lamps in private residences are to be paid for at the rate of $3 per month for 3 lamps, and each additional lamp is to cost 75 cents per month.

AT the annual meeting of the Charlestown (Mass.) Gas and Electric Company the following officers were elected: Directors, James F. Hunnewell, L. B. Hathon, Jr., A. Sawtell, Chas. F. Byam, John Turner, Joseph Stone and Mark F. Burns; President, James F. Hunnewell; Clerk and Treasurer, George B. Neal.

THE annual meeting of the Danvers (Mass.) Gas Light Company terminated in these selections: Directors, W. Eliot Fette, G. A. Tapley, L. A. Wyman and J. F. Porter; President, W. Eliot Fette; Treasurer, L. A. Wyman; Collector, J. F. Porter.

THE proprietors of the Milford (Mass.) Gas Company have placed two high candle power regenerative gas lamps at prominent street intersections, and the effect of the same is greatly admired by the residents.

THE Spencer (Mass.) Gas Company has elected the following officers: Directors, Luther Hill, Richard Sugden, Emerson Stone, G. P. Ladd, G. P. Prouty, William A. Barr and Edwin Evans; President, Luther Hill; Vice President, G. P. Ladd; Clerk, Emerson Stone; Treasurer, Edwin A. Hill.

THE proprietors of the Hudson County Gas Light Company, of Hoboken, N. J., have ordered a cut in the gas rate of 15 cents per 1,000 cubic feet, or from $1.90 to $1.75 per 1,000 cubic feet. The concession is to date from January 1st.

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PROPRIETORS.

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MONDAY, JANUARY 30, 1893.

The Market for Gas Securities.

Consolidated was the feature of the week, and decidedly so. On Friday week, shortly after the preparation of our review of the market, the shares—which were quoted at noon of that day at 139¾—sold up to 144, and the shares remained in the forties until Monday. Early that day a reaction set in, and what with realizing sales and advance knowledge of what was to be done at the annual meeting, such knowledge, however, being confined to the select few in Irving Place who pull the strings, a serious break occurred. To-day (Friday) the stock opened at 134 to 134½, and seemed to be weak. The only thing that we can say about the annual meeting is that the following Board of Trustees was chosen: Messrs. J. W. Smith, T. K. Lees, Oscar Zollikoffer, Thomas Rutter, H. E. Gawtrey, P. R. Pyne, Samuel Sloane, John P. Huggins, H. Clausen, Jr., Eugene Higgins, William Rockafellar, R. G. Rolston and Welcome S. Jarvis. What determination other than this was reached we cannot say, but presume that when the Board organizes a pyrotechnic financial display may be looked for. In the meantime, we understand the Company's earnings are sufficient to pay a dividend at the rate of 8 per cent. Equitable is booming at 198 to 200, and we imagine the proprietors will put out a trifle more capital this year. Mutual is going along smoothly. The wiseacres who believe that a gas rate cut will be ordered by the Legislature this year should bear in mind that the Murphy-Brady-Kelly-Flower combination in this State is very friendly to the gas interest just now. Some of them own large blocks of gas stocks, and these people are not given much to the practice of hurting themselves.

Over in Brooklyn negotiations are said to be moving nicely in respect of consolidation, and it is also worthy of remark that a bill to close Gowanus Canal is to be considered at Albany soon. It is only a question of time, as before remarked by us, when Brooklyn's infamous open sewer blot will be removed. Brooklyn shares are steady at the high figures previously reported. In fact, it is said that no less than four of the Companies are easily earning at the rate of 8 per cent. Chicago gas is again in the ascending scale, and we imagine it ought to bring par, say, by April 1st. Lacledes are regarded with indifference, Bay State is weaker on the introduction in the Legislature of a bill to put the gas rate in Boston at $1 per 1,000, and Baltimore Consolidated moved up sharply to 62½, subsequently reacting a trifle, or to 61¾. At auction: $1,000 Fulton-Municipal 6 per cent. bonds, at 107 and interest.

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